National Aeronautics and Space Administration

FY 1986 Safety Program Report

NASA Safety Division
Office of Safety, Reliability, Maintainability and Quality Assurance
Washington, D.C. 20546

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SAFETY PROGRAM OVERVIEW

Since the tragic loss of Challenger and its crew, the NASA team has dedicated itself to implementing the recommendations of the Rogers Commission and the House Science and Technology Committee in an effort to return the National Space Transportation System to safe flight status. Among those recommendations acted upon by the NASA Administrator within six months of the accident was the establishment of an Office of Safety, Reliability, Maintainability and Quality Assurance (SRM&QA) headed by an Associate Administrator reporting directly to the NASA Administrator. The functions of the new office were to be independent of other NASA program responsibilities.

On July 8, 1986, Dr. James Fletcher, NASA Administrator, announced the appointment of Mr. George A. Rodney to the position of Associate Administrator for the Office of SRM&QA. The responsibilities of his office include the oversight of safety, reliability, maintainability and quality assurance functions related to all NASA activities and programs as well as the implementation of a system for anomaly documentation and resolution and a trend analysis program.

One of the first activities undertaken by Mr. Rodney was the assessment of the resources including workforce required to ensure adequate execution of the safety organization functions. Based on his assessment plans were made to increase the size of the staff at Headquarters and to reorganize and augment the safety, reliability, and quality assurance organizations at the field installations to mirror the Headquarters operation.

The Headquarters Safety Division developed a plan for an enhanced safety program. In FY 1986 three branches were established within the division: institutional safety, operational safety and system safety. In 1987 a risk management program will be implemented as well as a safety information system.

During fiscal year 1987 NASA will continue with the implementation of recommendations made by the Rogers Commission and the Congressional Committee. The NASA team is working tirelessly to restore the STS fleet to flight status and to return the United States to a position of global importance in the manned exploration of space.

Robert H. Thompson

Robert H. Thompson
Director, Safety Division

FY 1986 SAFETY STATISTICS

Fatalities	3*
Total injuries/illnesses	196
Lost time injuries/illnesses	86
Lost wages	$98,492
Material Losses	$1,128,400
Chargeback billing	$5,392,238
Total losses	$6,619,130

*NASA employees lost in Challenger mishap.

NASA OCCUPATIONAL INJURY/ILLNESS RECORD

Injuries and illness are divided into two classes, lost time cases and no lost time cases. A lost time case is defined by OSHA as a nonfatal, traumatic injury that causes loss of time from work or disability beyond the day or shift when the injury occurred, or a nonfatal illness/disease that causes loss of time from work or disability at any time. A no lost time case is a nonfatal injury (traumatic) or illness/disease (nontraumatic) that does not meet the definition of a lost time case.

The NASA Headquarters Safety Division does not track all lost time cases as defined by OSHA but instead identifies those which are clearly work-related injuries for which preventive action or corrective action plans may be developed to prevent recurrence.

The number of lost time injuries/illnesses per 200,000 hours workea is a gross rate which expresses the number of lost time cases in relation to the number of hours worked. OSHA now uses a different formula to calculate incidence rates: the number of lost time cases per 100 employees. Several charts in this report reflect this formula.

Table 1 shows injury/illness statistics for all NASA field installations for FY 1986. The overall lost time rate for NASA increased slightly from 0.38 in FY 1985 to 0.43 in FY 1986.

TABLE 1. NASA INJURY/ILLNESS DATA BY INSTALLATION - FY 1986

	NO. OF EMPLOYEES	HOURS WORKED IN (K)	TOTAL INJURY/ ILLNESS DATA			LOST TIME INJURY/ILLNESS DATA					PERFORMANCE VS GOAL FOR FY 86	
			NO. CASES	FREQ. RATE 1985	FREQ. RATE 1986	NO. CASES	NO. DAYS	FREQ. RATE 1985	FREQ. RATE 1986	SEVERITY RATE	CUM. RATE	TARGET RATE
ARC/DFRF	2,181	3,928	38	0.50	1.93	17	224	0.30	0.87	11.40	0.87	0.30
GSFC/WFF	3,816	6,022	25	0.80	0.83	8	17	0.23	0.27	0.56	0.27	0.40
HQ	1,537	2,772	16	1.78	1.15	7	33	0.50	0.51	2.38	0.51	0.30
JSC	3,577	6,043	29	0.23	0.96	13	206	0.23	0.43	6.82	0.43	0.30
KSC	2,124	4,558	7	0.93	0.31	2	14	0.59	0.09	0.61	0.09	0.30
LaRC	2,925	5,152	14	0.48	0.54	5	18	0.22	0.19	0.70	0.19	0.40
LeRC	2,772	5,156	43	0.99	1.67	24	388	0.82	0.93	15.05	0.93	0.30
MSFC	3,232	5,992	24	0.63	0.80	10	29	0.33	0.33	0.97	0.33	0.60
NSTL	137	284	0	0.71	0	0	0	0	0	0	0	0.30
NASA	22,301	39,907	196	—	0.98	86	929	—	0.43	4.66	0.43	
LAST YEAR	22,664	41,352	199	0.96	—	78	820	0.38	—	3.97	0.38	

1. Total injury/illness frequency rate = number of cases per 200,000 hours worked.
2. Lost time injury/illness frequency rate = number of lost workday cases per 200,000 hours worked.
3. Injury/illness severity rate = number of lost workdays per 200,000 hours worked.

Figure 1 illustrates the relative position of the NASA occupational injury/illness incidence rate compared to other Federal agencies having more than 15,000 employees in FY 1985 and FY 1986. Within the Federal Government NASA ranked second in both years. These statistics are based on the number of lost-time cases per 100 employees.

Figure 2 plots the NASA lost time injury/illness rates for the last 11 years against those of other Federal agencies and select private sector industries. NASA's rates have been consistently lower than those of the Federal Government and the private sector. The most recent statistics available from the Department of Labor for private sector industry are for FY 1985.

Figure 3 illustrates NASA's excellent overall illness/injury record as compared to all other Federal agencies, the private sector, private sector manufacturing industry, and the private sector aerospace industry over the last 11 years. The most recent statistics available from the Department of Labor are for FY 1985.

Figure 4 compares the lost time frequency rates at the NASA field installations to the overall NASA lost time frequency rate of 0.43 for FY 1986. These statistics are based on the number of lost time cases per 200,000 hours worked.

Figure 5 compares the lost time severity rates at the NASA field installations to the overall NASA lost time severity rate. NASA's severity rate increased to 4.66 days lost per 200,000 hours worked in FY 1986 from 3.97 days in FY 1985.

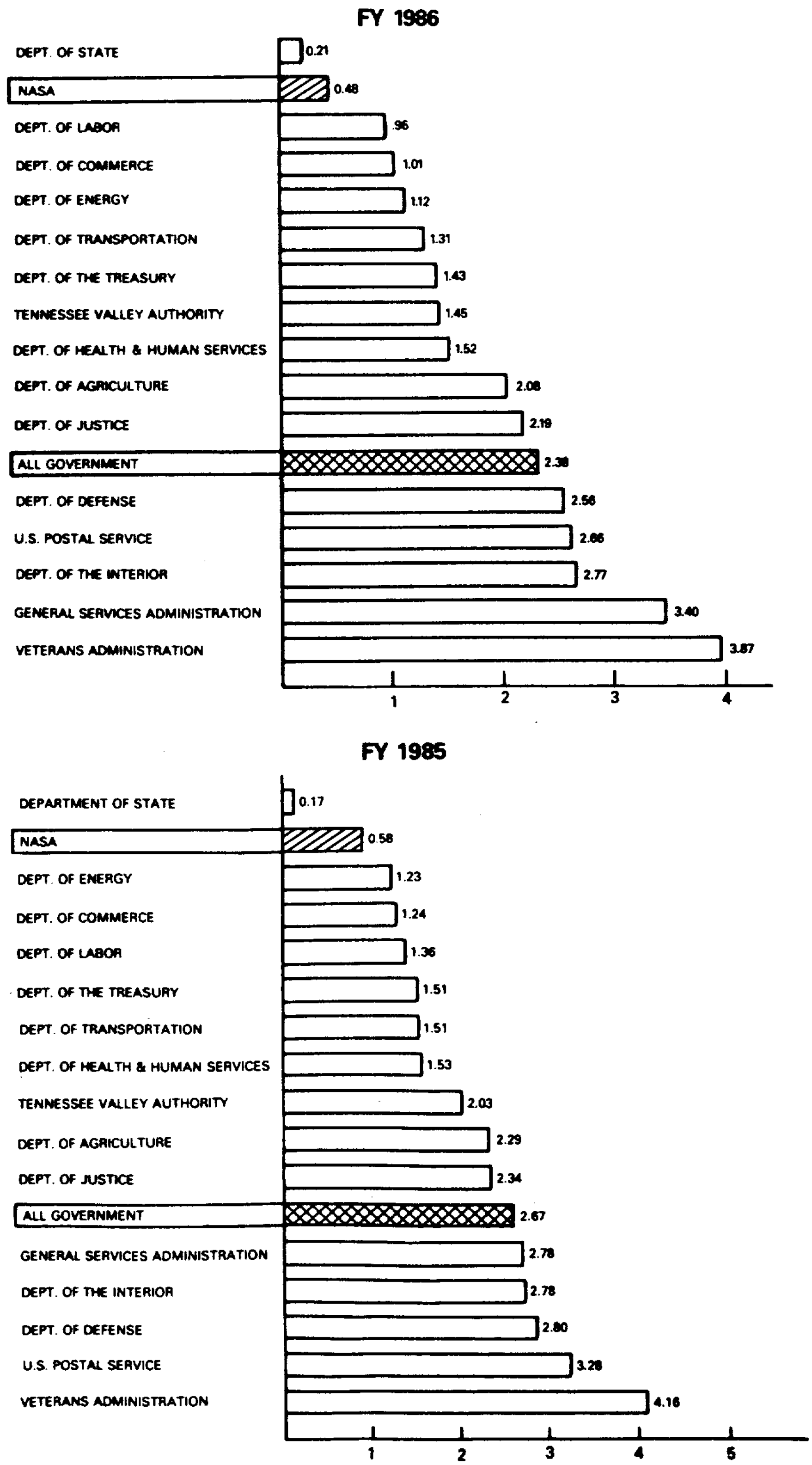
Figure 6 compares the number of NASA employees to the number of lost time cases over the past 11 years.

Figure 7 plots the lost time frequency rate, the no lost time rate, and the total reportable rate per 200,000 hours worked. NASA experienced an increase in the rates for all cases and lost time cases in FY 1986.

Table 2 shows the lost time rates for both NASA civil service and contractor employees by installation. The contractor lost time rate of 0.96 reflects an increase over the rate for FY 1985.

Figure 8 compares the lost time frequency rates of NASA and contractor employees at each installation for the last two years.

LOST-TIME INJURY/ILLNESS RATES IN SELECT FEDERAL AGENCIES*



* HAVING MORE THAN 15,000 EMPLOYEES
+ OSHA NO LONGER CALCULATES RATES BASED ON 200,000 HOURS WORKED

Figure 1

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LOST-TIME OCCUPATIONAL INJURY/ILLNESS RATES:

PRIVATE SECTORS-ALL FEDERAL AGENCIES-NASA

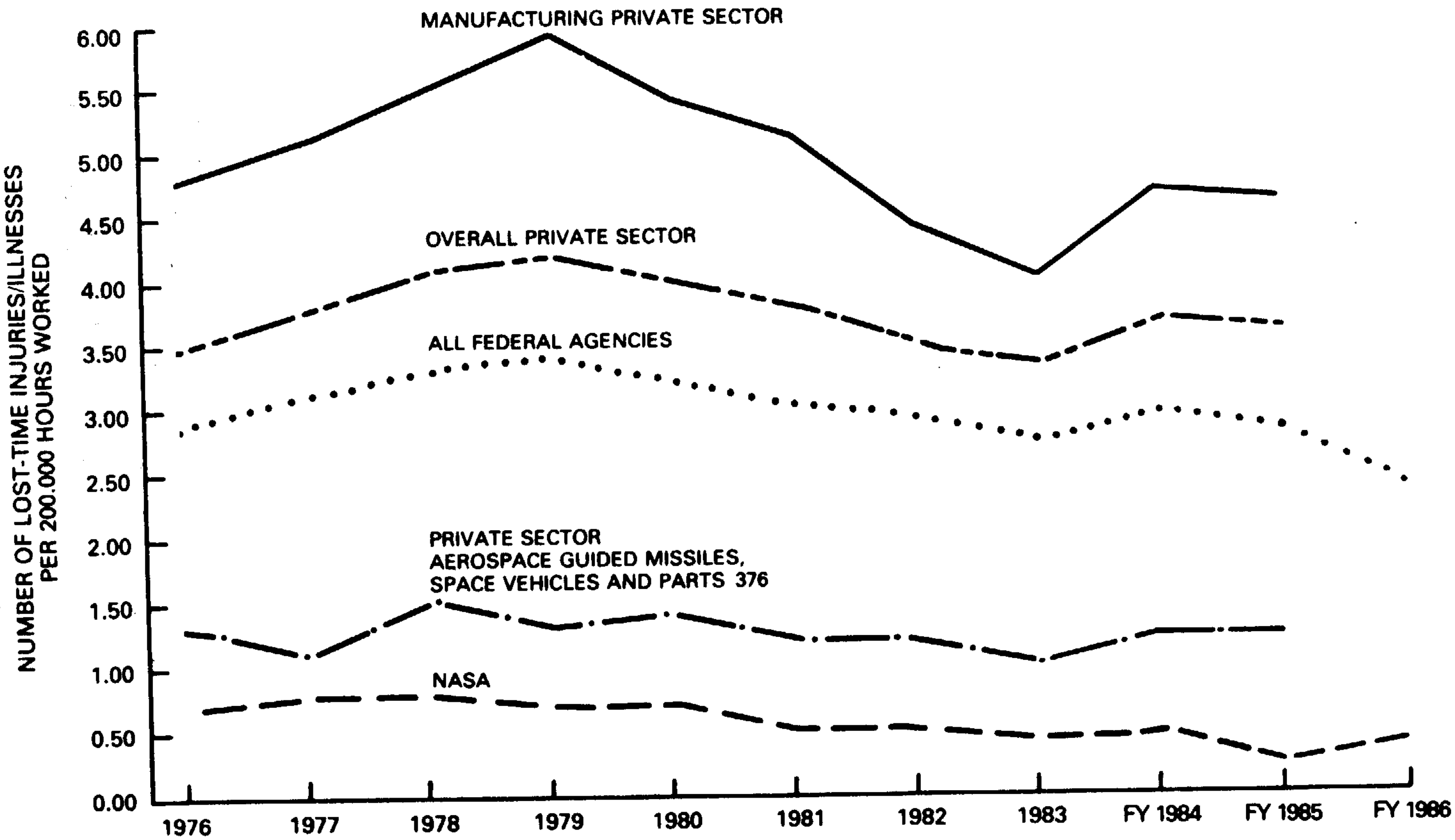

Figure 2
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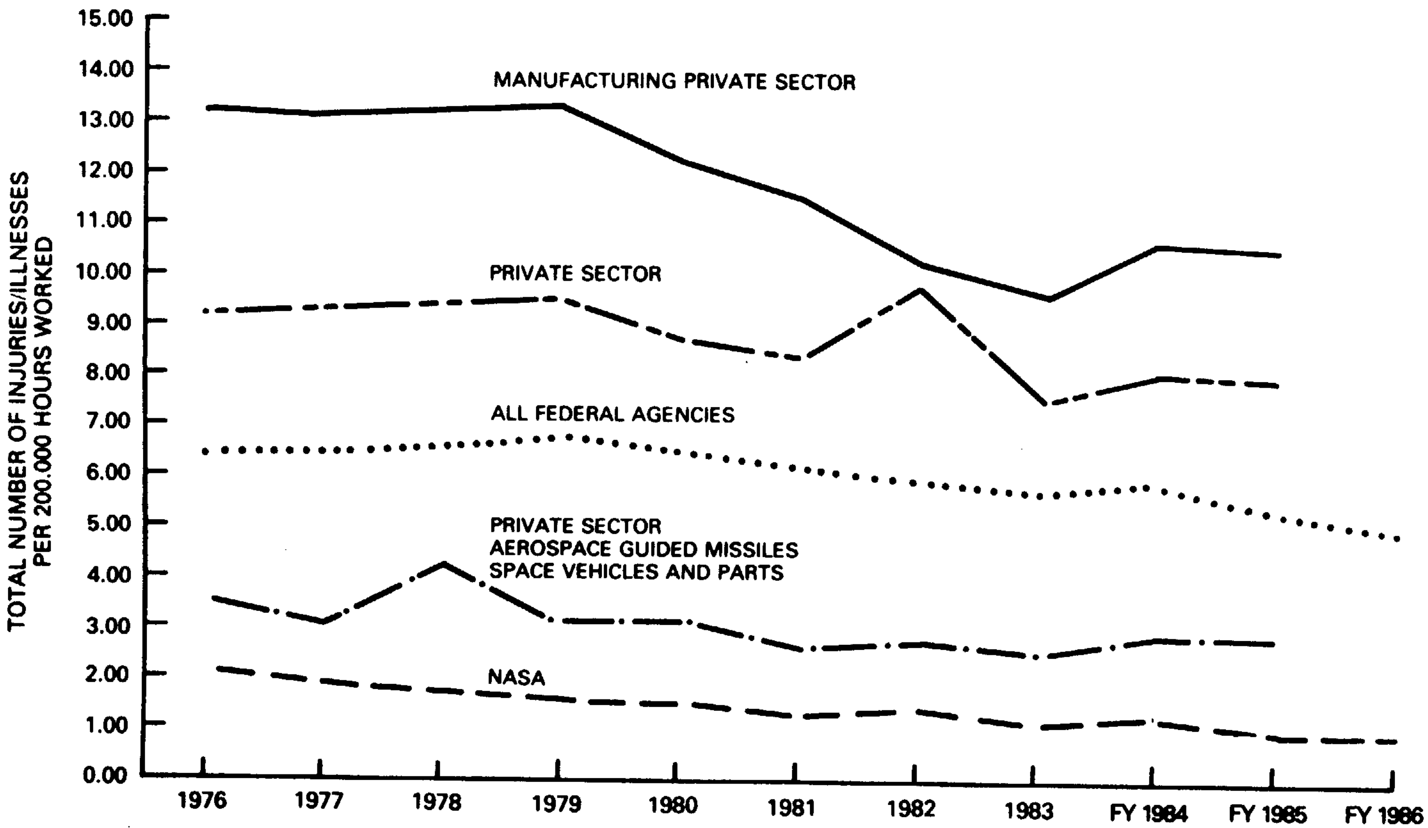
Rev. 10-19-87

TOTAL OCCUPATIONAL INJURY/ILLNESS RATES:

PRIVATE SECTORS-ALL FEDERAL AGENCIES-NASA



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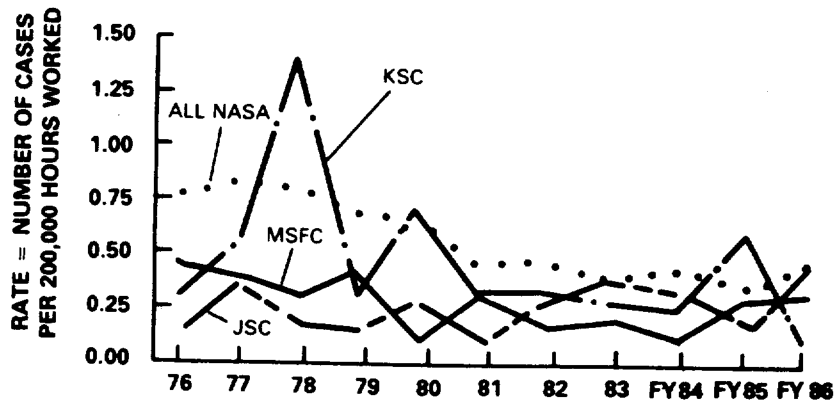
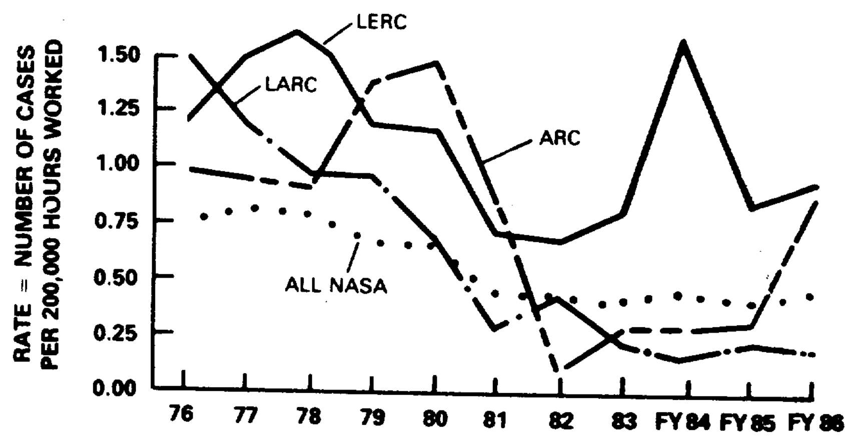
Rev. 10-19-87

Figure 3

LOST TIME INJURY/ILLNESS FREQUENCY RATES 1976-1986





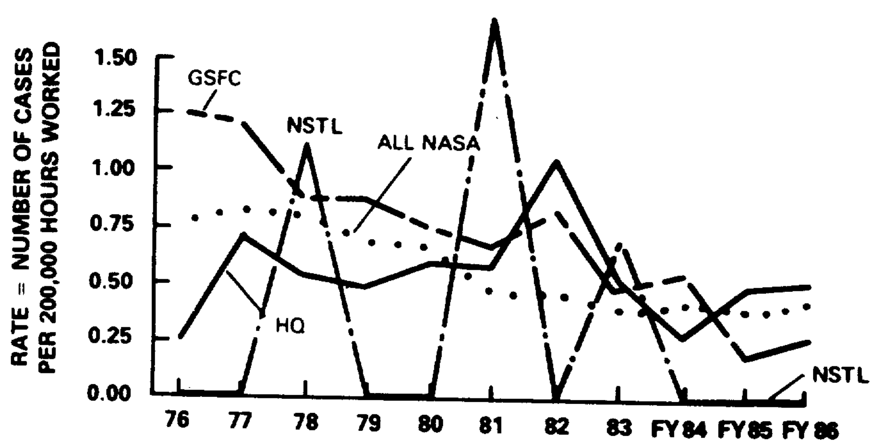


Figure 4

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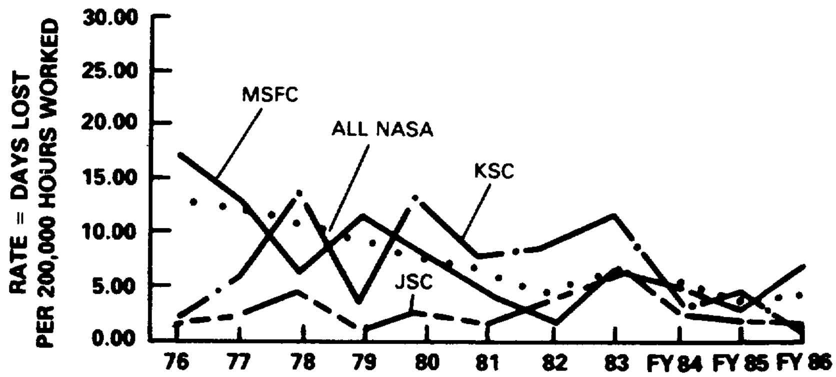
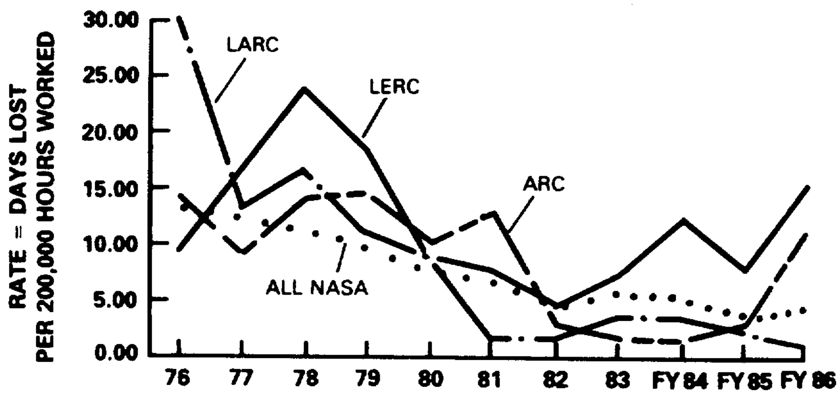
Rev. 10-19-87

INJURY/ILLNESS SEVERITY RATES 1976-1986





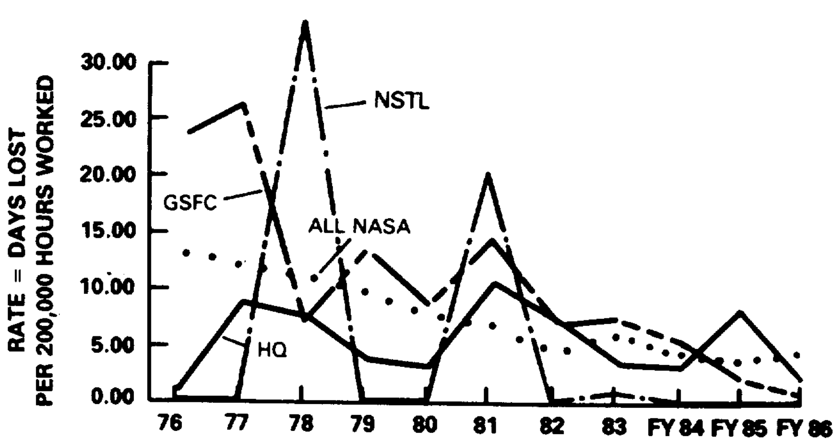


Figure 5

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Rev. 10-19-87

NUMBER OF NASA EMPLOYEES AND NUMBER OF LOST TIME INJURIES VS TIME 1976-1986

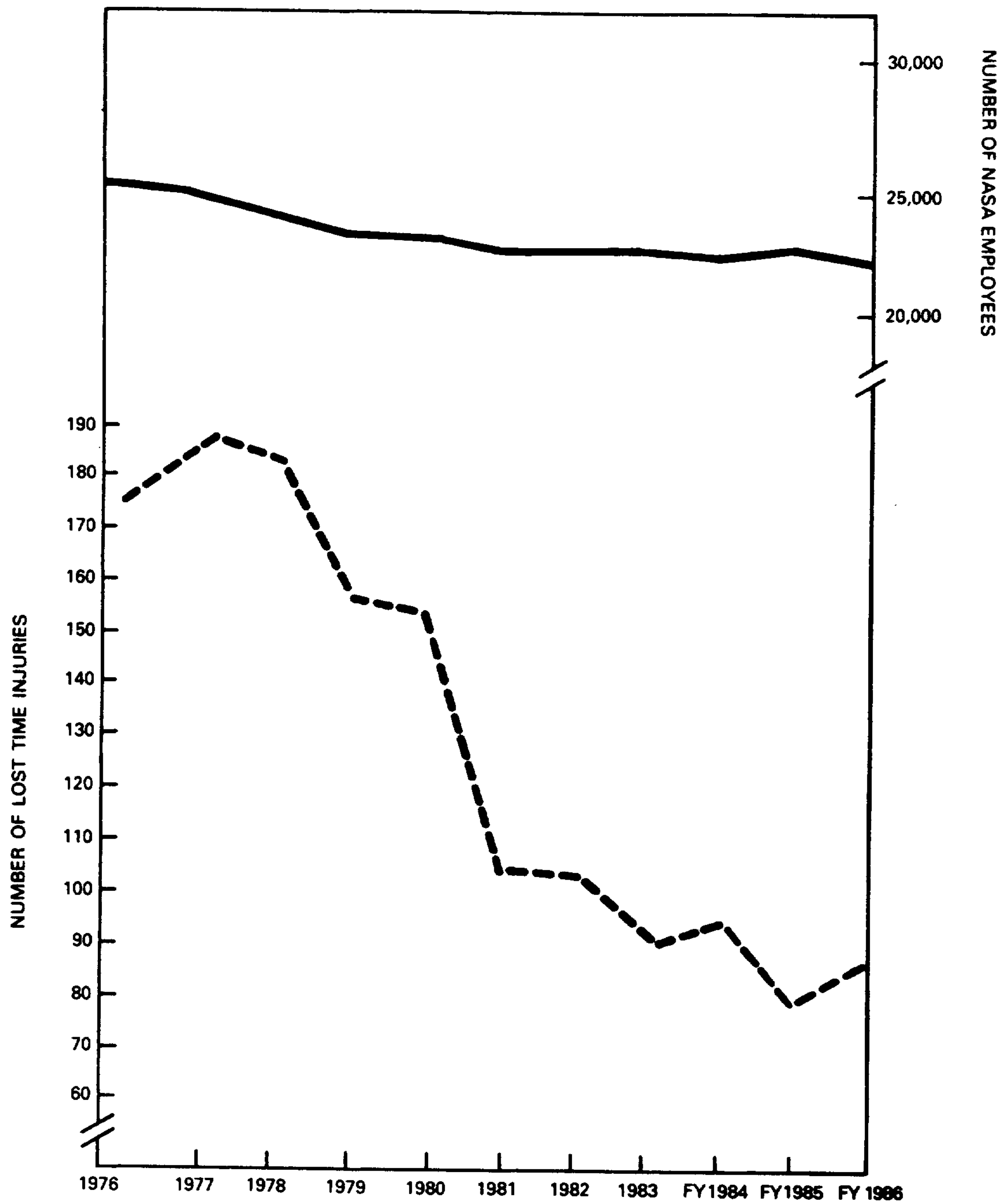

Figure 6

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Rev. 10-19-87

Figure 7
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NASA OCCUPATIONAL INJURY/ILLNESS* RATES**
1976-1986

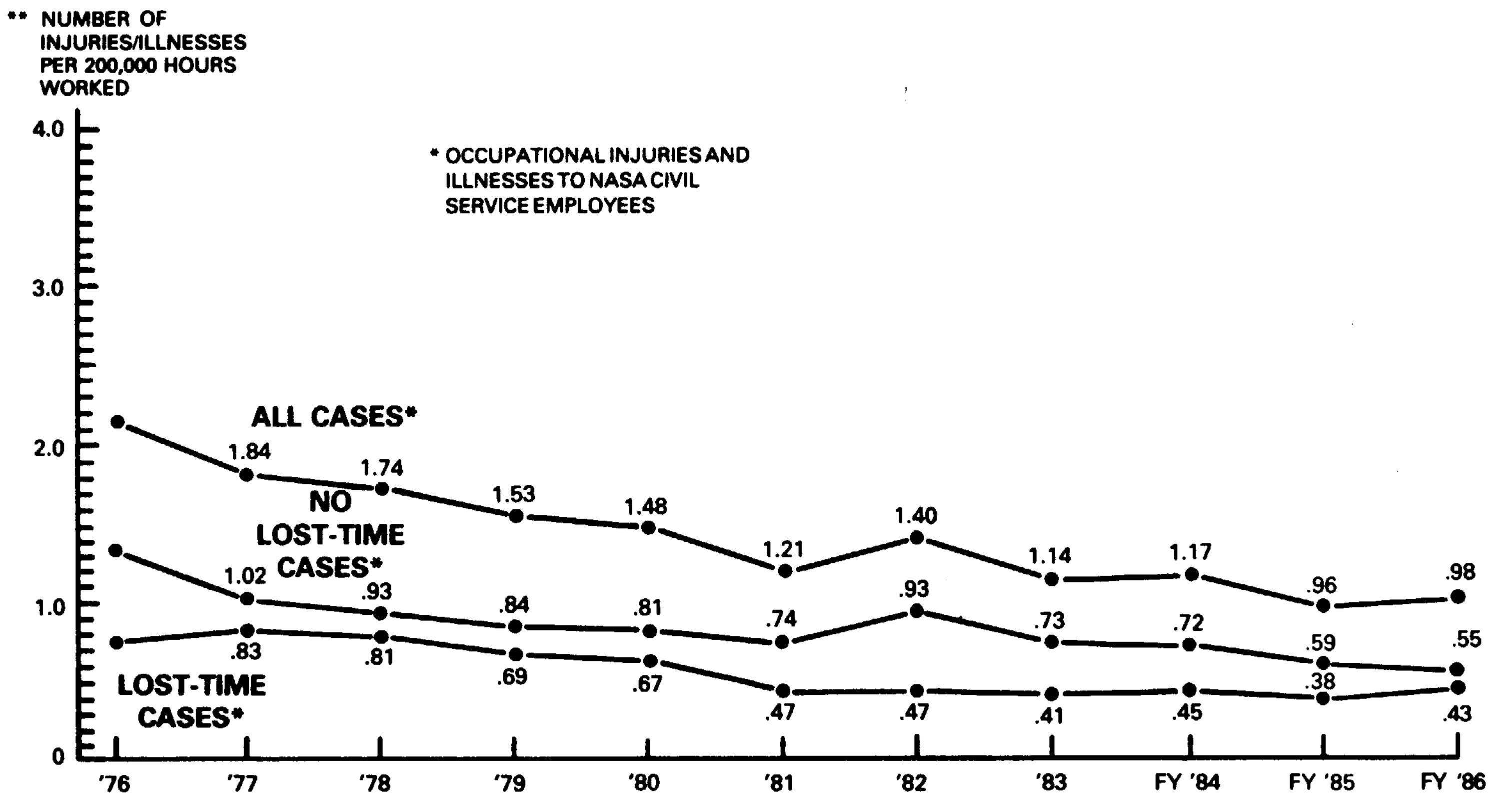
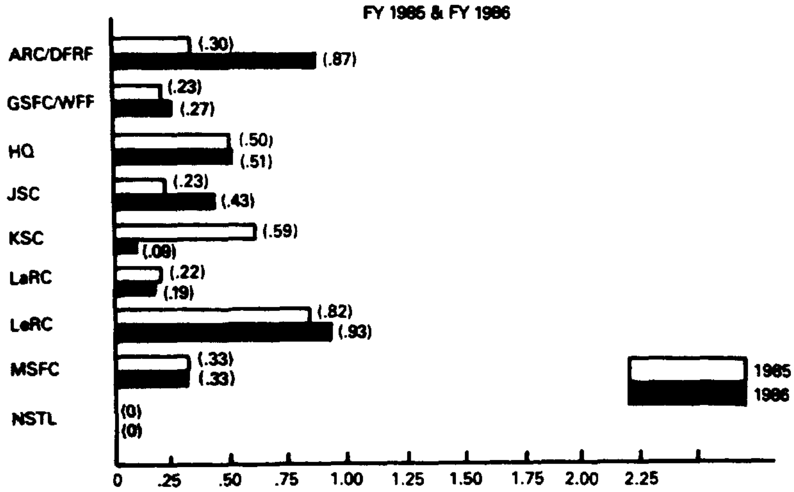


TABLE 2. NASA COMBINED INJURY/ILLNESS DATA BY INSTALLATION - FY 1986
CIVIL SERVICE AND CONTRACTOR EMPLOYEES

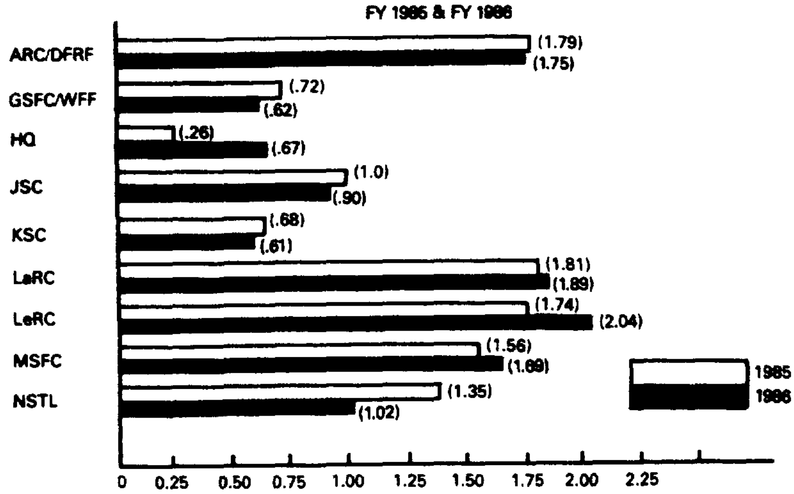
	HOURS (K) CIV. SERV. EMPLOYEES	NO. L-T CASES	FREQ. RATE	HOURS (K) CONTRACTOR EMPLOYEES	NO. L-T CASES	FREQ. RATE	HOURS (K) COMBINED TOTAL	TOTAL L-T CASES	COMBINED FREQ. RATE
ARC/DFRF	3,928	17	0.87	3,079	27	1.75	7,007	44	1.26
GSFC/WFF	6,022	8	0.27	8,773	27	0.62	14,795	35	0.47
HQ	2,772	7	0.51	901	3	0.67	3,673	10	0.54
JPL	---	-	—	11,497	66	1.15	11,497	66	1.15
JSC	6,043	13	0.43	19,205	86	0.90	25,248	99	0.78
KSC	4,558	2	0.09	23,271	71	0.61	27,829	75	0.54
LARC	5,152	5	0.19	2,969	28	1.89	8,121	33	0.81
LERC	5,156	24	0.93	1,866	19	2.04	7,022	43	1.22
MSFC	5,992	10	0.33	3,323	28	1.69	9,315	38	0.82
NSTL	284	0	0	1,761	9	1.02	2,045	9	0.88
NASA	39,907	86	0.43	76,645	366	0.96	116,552	452	0.78
LAST YEAR	41,352	78	0.38	73,233	334	0.91	114,615	403	0.70

Lost time injury/illness frequency rate = number of lost workday cases per 200,000 hours worked.

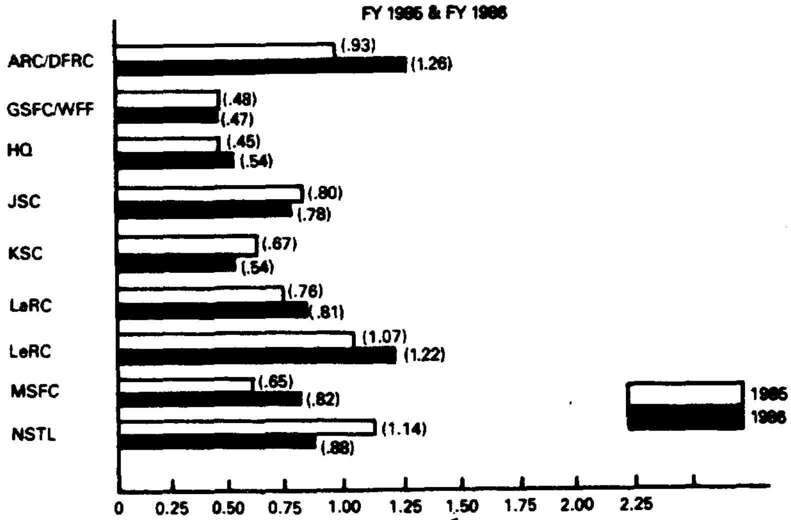
NASA FEDERAL EMPLOYEES
LOST-TIME ILLNESS/INJURY RATES*
FY 1985 & FY 1986



CONTRACTOR EMPLOYEES
LOST-TIME ILLNESS/INJURY RATES*
FY 1985 & FY 1986



COMBINED NASA AND CONTRACTOR EMPLOYEES
LOST-TIME ILLNESS/INJURY RATES*
FY 1985 & FY 1986



*RATE = NUMBER OF CASES PER 200,000 HOURS WORKED.

Figure 8

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Rev. 10-19087

CHARGEBACK BILLING

Chargeback is defined by OSHA as a system under which the U.S. Department of Labor pays compensation and medical costs attributed to injuries which occurred after December 1, 1960 and then bills the agency which employed the individual who received compensation or benefits. In any given year, most of the chargeback billing is a result of illnesses and injuries which occurred in previous years. Only 1.2% of the chargeback billing costs paid in FY 1986 was for mishaps which actually occurred during that year.

Figure 9 illustrates the relationship between chargeback billing and lost wages.

Figure 10 illustrates the relationship between chargeback billing and all other mishap- and injury-related costs. These include lost wages (continuation of pay) as well as aviation, automobile, fire, and other reportable mishaps. Of the $6.6 million total loss for FY 1986, $5.4 million, or 82%, was paid out in chargeback billing costs.

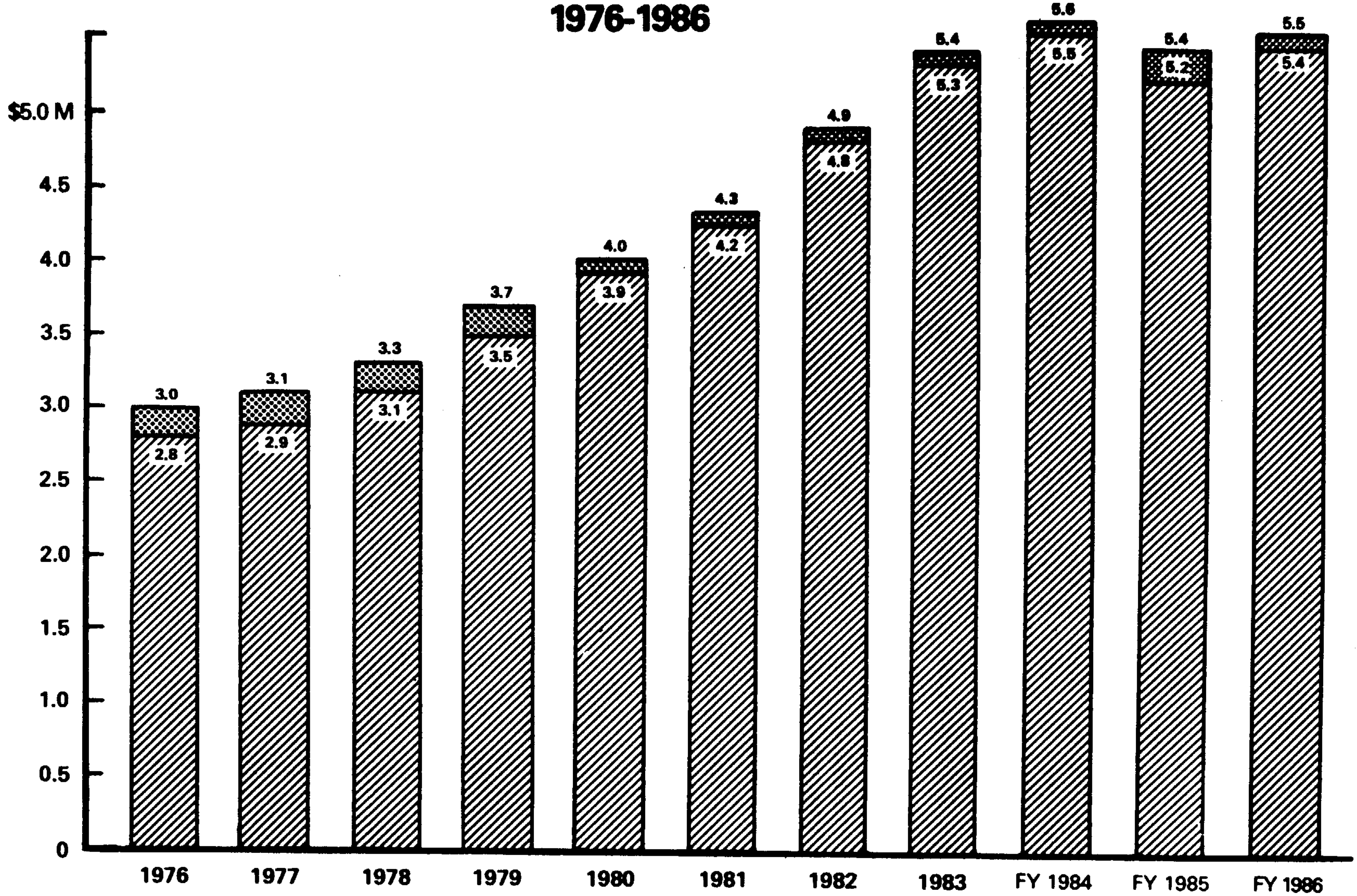
Figure 11 illustrates the upward trend of chargeback billing in the Federal Government and in NASA for the last 11 years.

MATERIAL LOSSES

Table 3 lists the statistics for NASA material losses during FY 1986. Rescheduling and equipment replacement costs from major mission failures such as the Space Shuttle Challenger accident and the loss of the Delta 178/GOES-G are not included in the statistics due to the difficulty of determining impact. Summaries of these and other major mishaps which occurred in FY 1986 begin on page 33.

Figure 12 illustrates the total cost of material losses over the last 11 years.

NASA LOSSES DUE TO INJURIES/ ILLNESSES
(IN MILLIONS OF DOLLARS)
1976-1986



INCLUDES LOST WAGES AND CHARGE BACK BILLING TO THE FEDERAL EMPLOYEES COMPENSATION FUND.

LOST WAGES   CHARGE BACK BILLING

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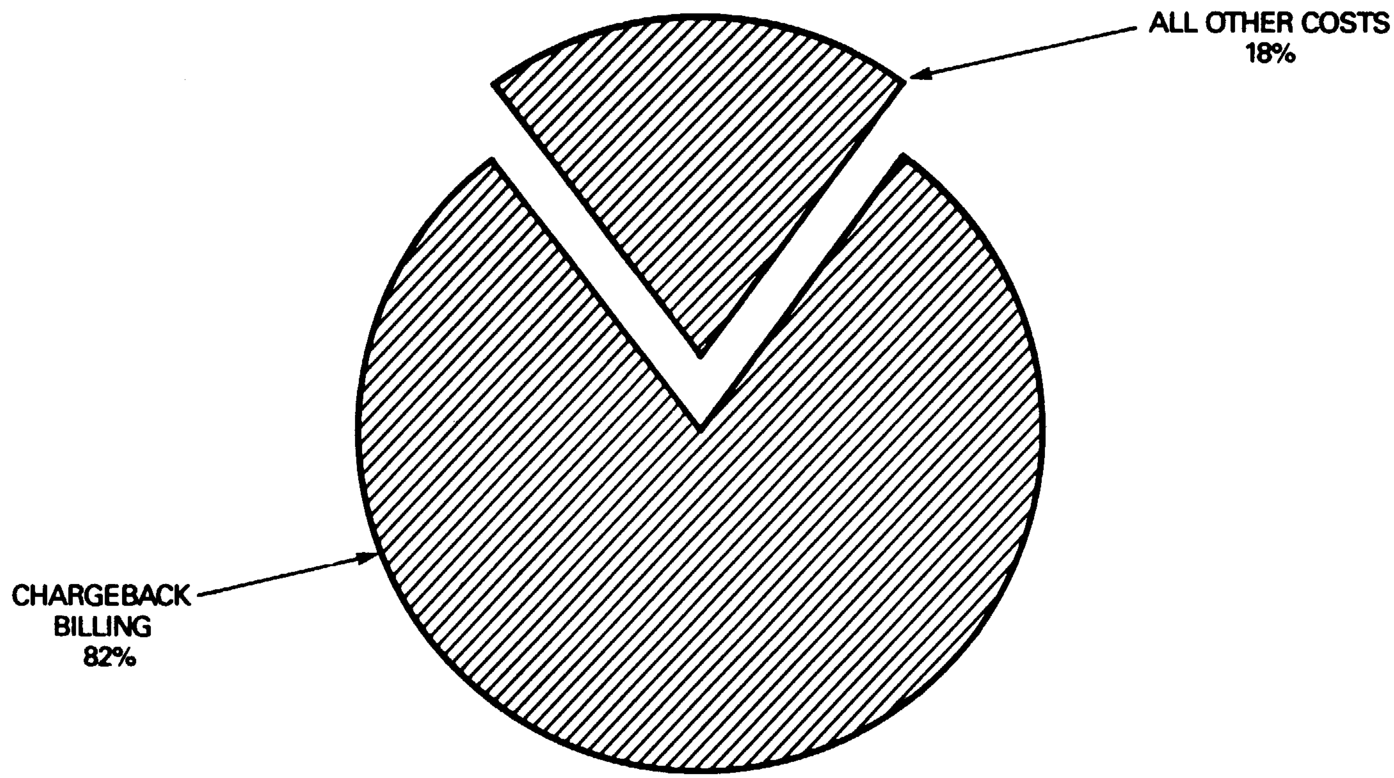
Rev. 10-19-87

Figure 9

COST OF FY 86 NASA MISHAPS/INJURIES

* TOTAL LOSS = $6,619,130



* DOES NOT INCLUDE
COST OF MISSION FAILURES
AND TEST OPERATIONS LOSSES

Figure 10

NASA HQ QS86-400
Rev. 10-19-87

TIME HISTORY OF (OWCP) CHARGEBACK BILLINGS
COSTS FOR ALL FEDERAL GOVERNMENT AGENCIES AND NASA
(IN MILLIONS OF DOLLARS)

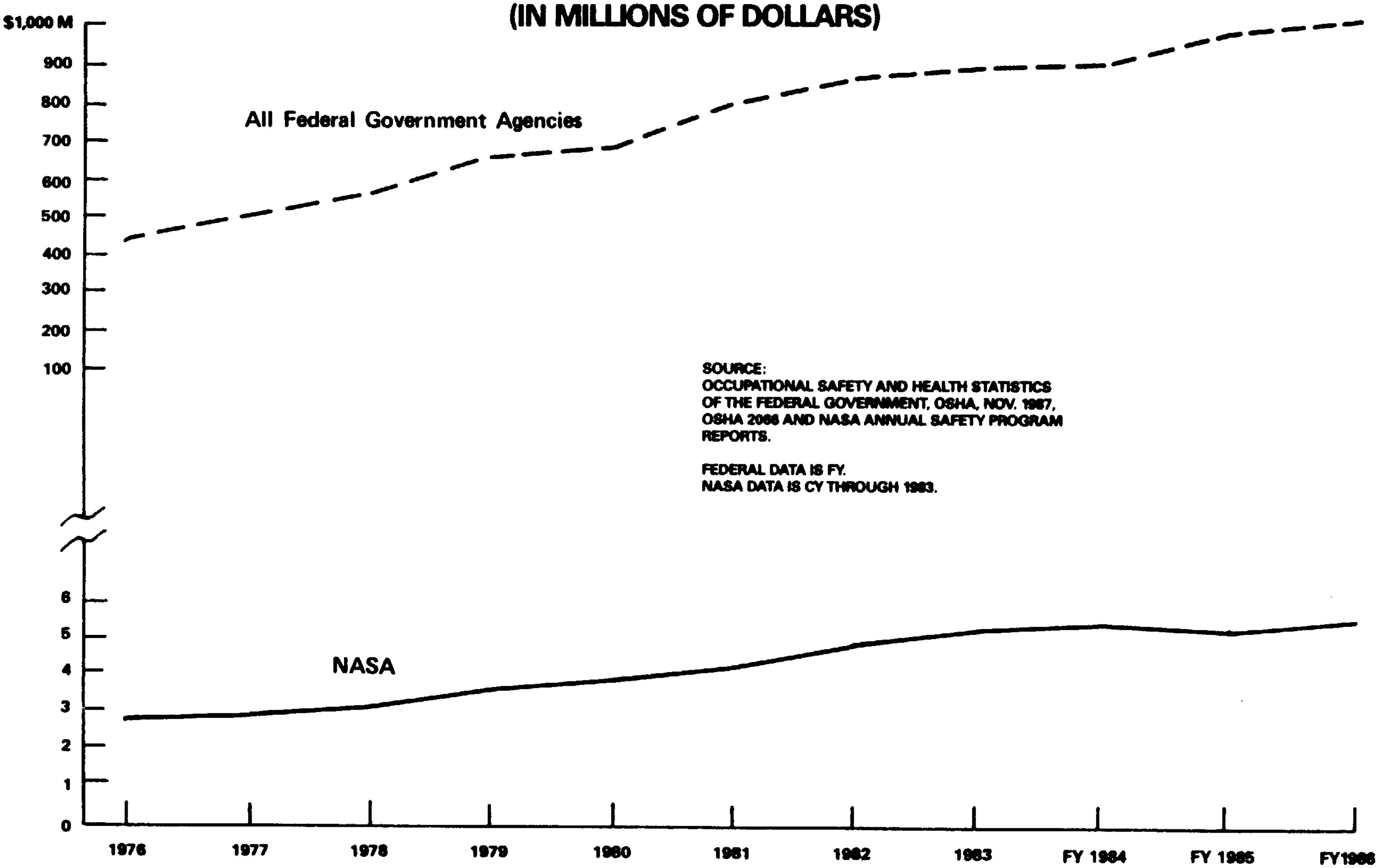


Figure 11

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TABLE 3. NASA MATERIAL LOSSES BY INSTALLATION - FY 1986
(COSTS ARE IN THOUSANDS OF DOLLARS)

	AUTO MISHAPS GOV		AUTO MISHAPS POV		AIRCRAFT MISHAPS		FIRE LOSSES		OTHER MISHAPS		TOTALS		
	NO.	COST	NO.	COST	NO.	COST	NO.	COST	NO.	COST	TORT COSTS	NO. MISHAPS	COST
ARC/DFRF	1	1.3	0	0	0	0	0	0	0	0	$ 0	1	$ 1.3
GSFC/WFF	7	11.7	0	0	0	0	0	0	0	0	0	7	11.7
HQ	3	2.0	0	0	0	0	0	0	0	0	0	3	2.0
JSC	7	6.7	0	0	0	0	0	0	0	0	0	7	6.7
KSC	13	34.7	1	0.9	0	0	0	0	29	726.9	1.5	43	764.0
LaRC	1	1.2	0	0	0	0	0	0	7	330.3	3.7	8	335.2
LeRC	0	0	0	0	0	0	0	0	0	0	0.6	0	0.6
MSFC	2	3.6	0	0	0	0	0	0	0	0	3.3	2	6.9
NSTL	0	0	0	0	0	0	0	0	0	0	0	0	0
NASA	34	61.2	1	0.9	0	0	0	0	36	1,057.2	9.1	71	1,128.4
LAST YEAR	15	28.7	1	1.1	2	18,760	0	0	40	6,224.6	11.9	58	25,026.3

1. Auto Mishaps for GOVs include GSA leased vehicles, and for POVs, rental cars.
2. Tort Costs are for claims paid in this reporting period.
3. Cost of Mission Failures is not included in total monetary losses.

NASA MATERIAL LOSSES DUE TO MISHAPS*
(IN MILLIONS OF DOLLARS)
1976-1986

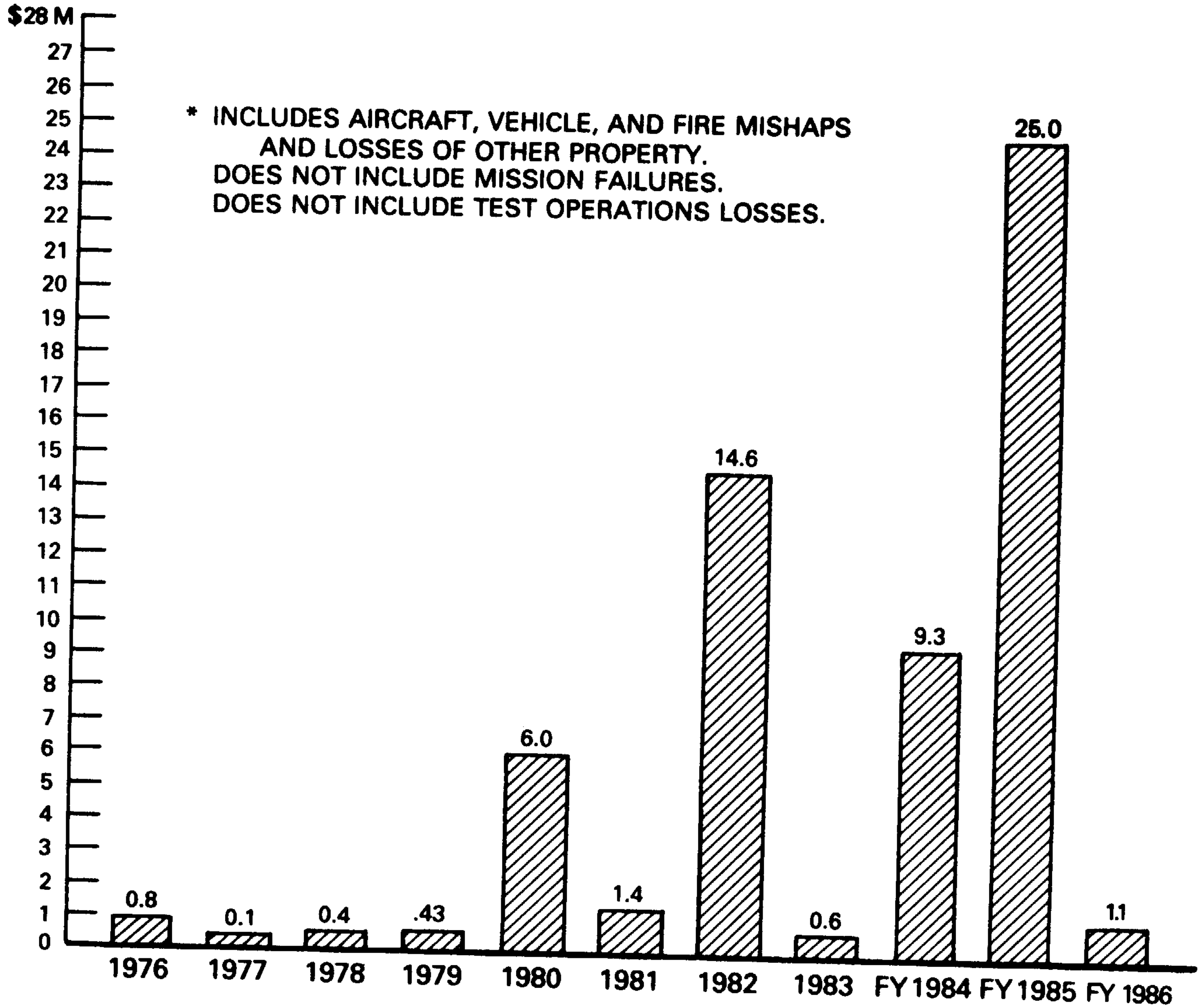

Figure 12

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NASA AVIATION SAFETY RECORD

NASA experienced no aircraft mishaps in FY 1986.

Figure 13 illustrates the cost of aircraft losses over the last 11 years.

NASA MOTOR VEHICLE SAFETY RECORD

NASA's FY 1986 government automobile accident frequency rate increased to 1.74 accidents per million miles driven. This rate was significantly lower that the goal of 5.0 established by NASA in 1980. The cost of reportable accidents, however, was the highest recorded in over 11 years.

Figures 14 and 15 show the frequency rates and costs of automobile accidents for the last 11 years.

NASA FIRE EXPERIENCE

As shown in Figures 16 and 17, NASA has experienced no reportable fires in in the last two years. NASA's excellent record in fire experience is a reflection of successful fire prevention programs throughout the agency.

NASA AIRCRAFT LOSSES
(IN MILLIONS OF DOLLARS)
1976-1986

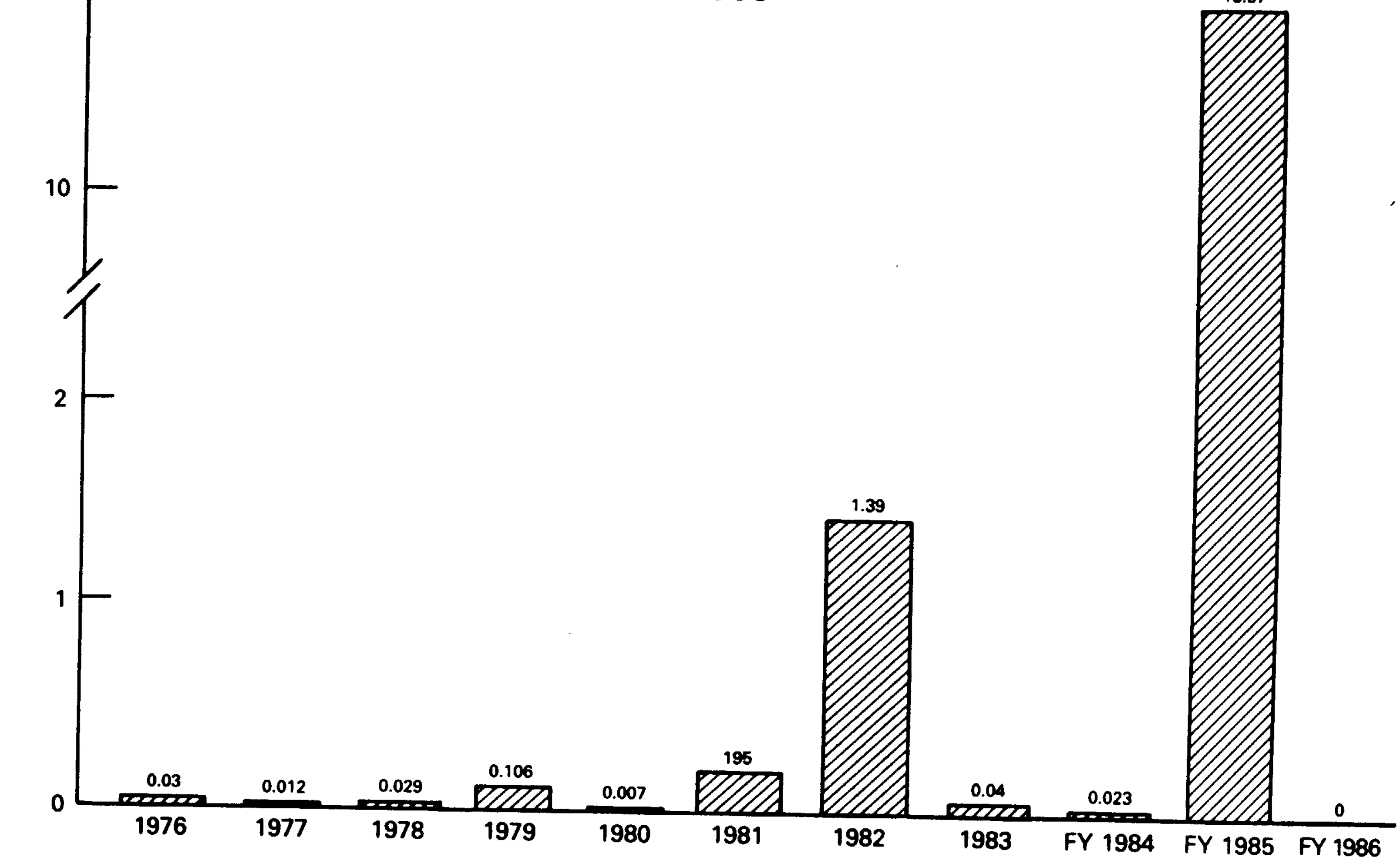

Figure 13

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Rev. 10-19-87

Figure 14
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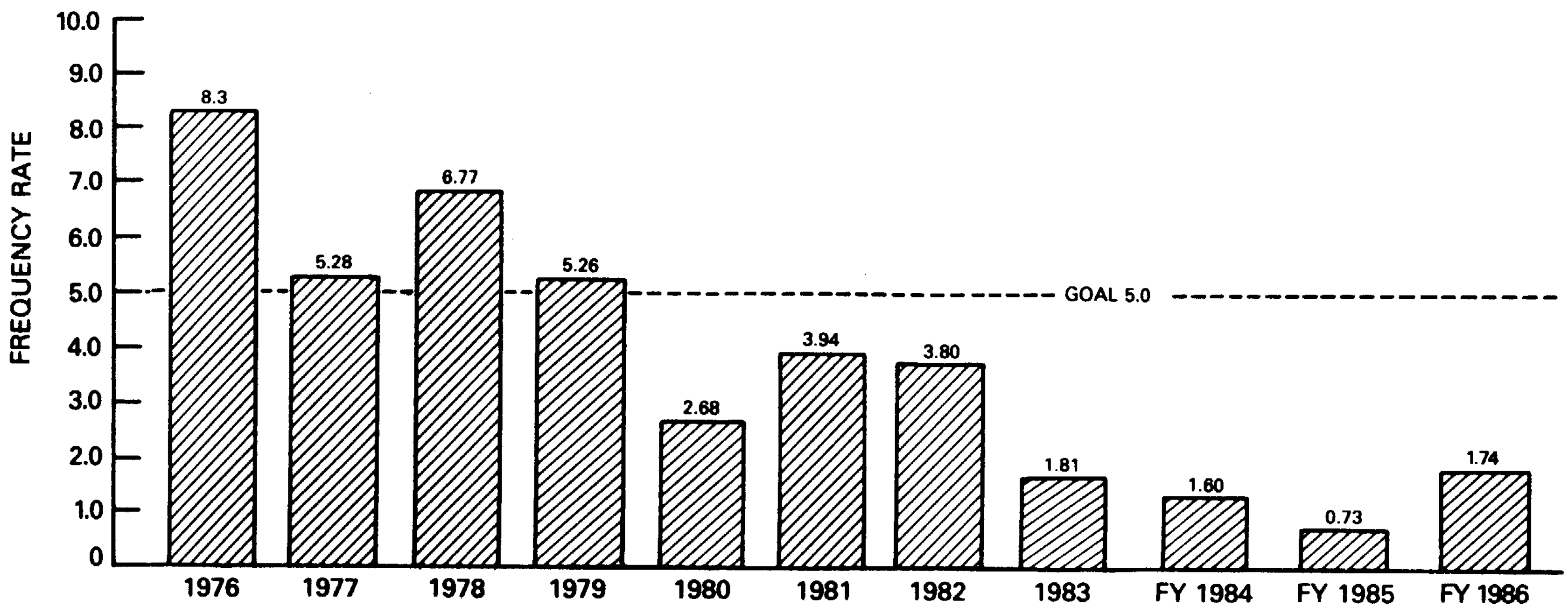
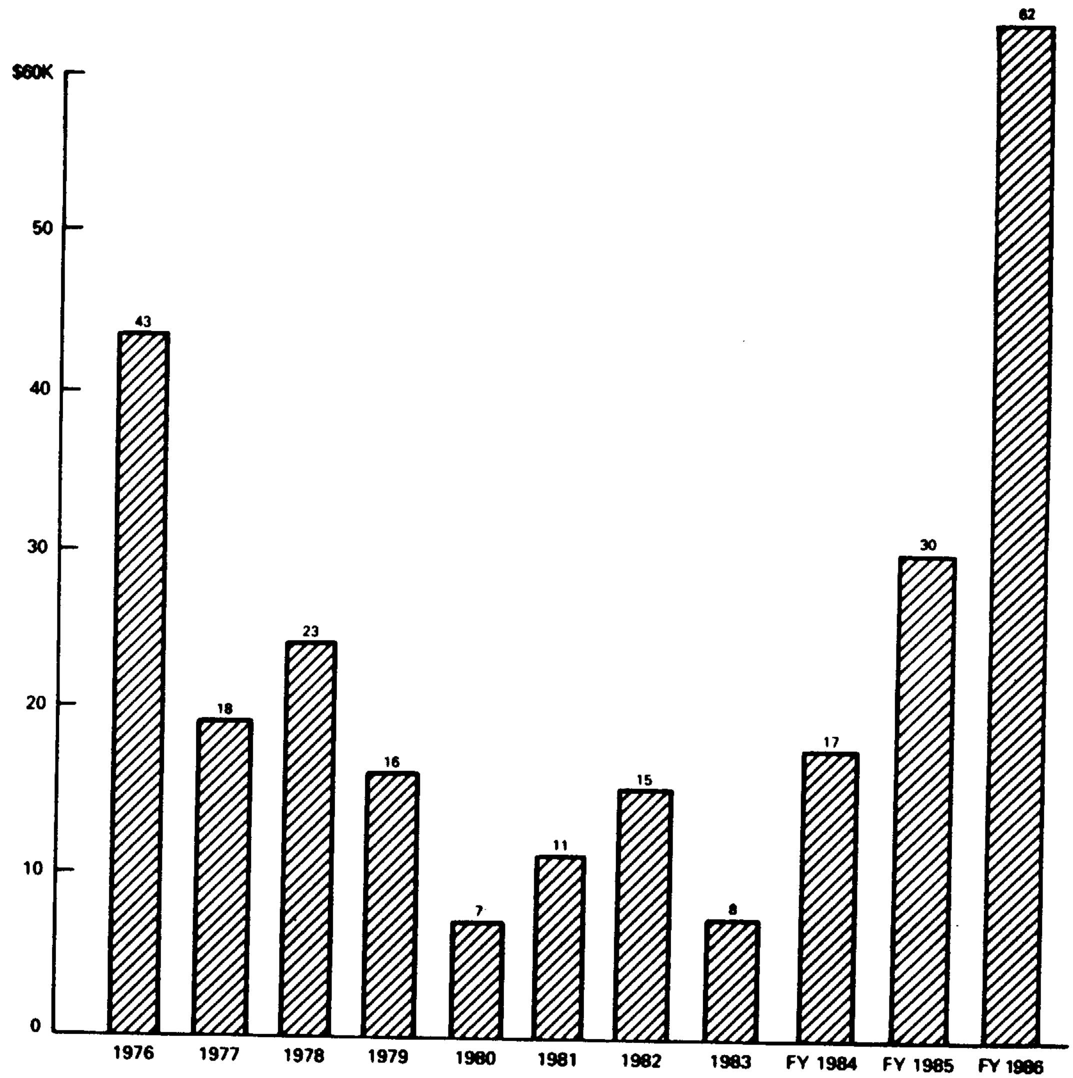
NASA GOVERNMENT MOTOR VEHICLE ACCIDENT FREQUENCY RATES 1976-1986



FREQUENCY RATE IS THE NUMBER OF MOTOR VEHICLE ACCIDENTS PER MILLION MILES DRIVEN.

NASA HQ QS86-403E (1)
Rev. 10-19-87

NASA MOTOR VEHICLE ACCIDENT LOSSES
GOV AND POV
(IN THOUSANDS OF DOLLARS)
1976-1986



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Rev. 10-19-87

Figure 16

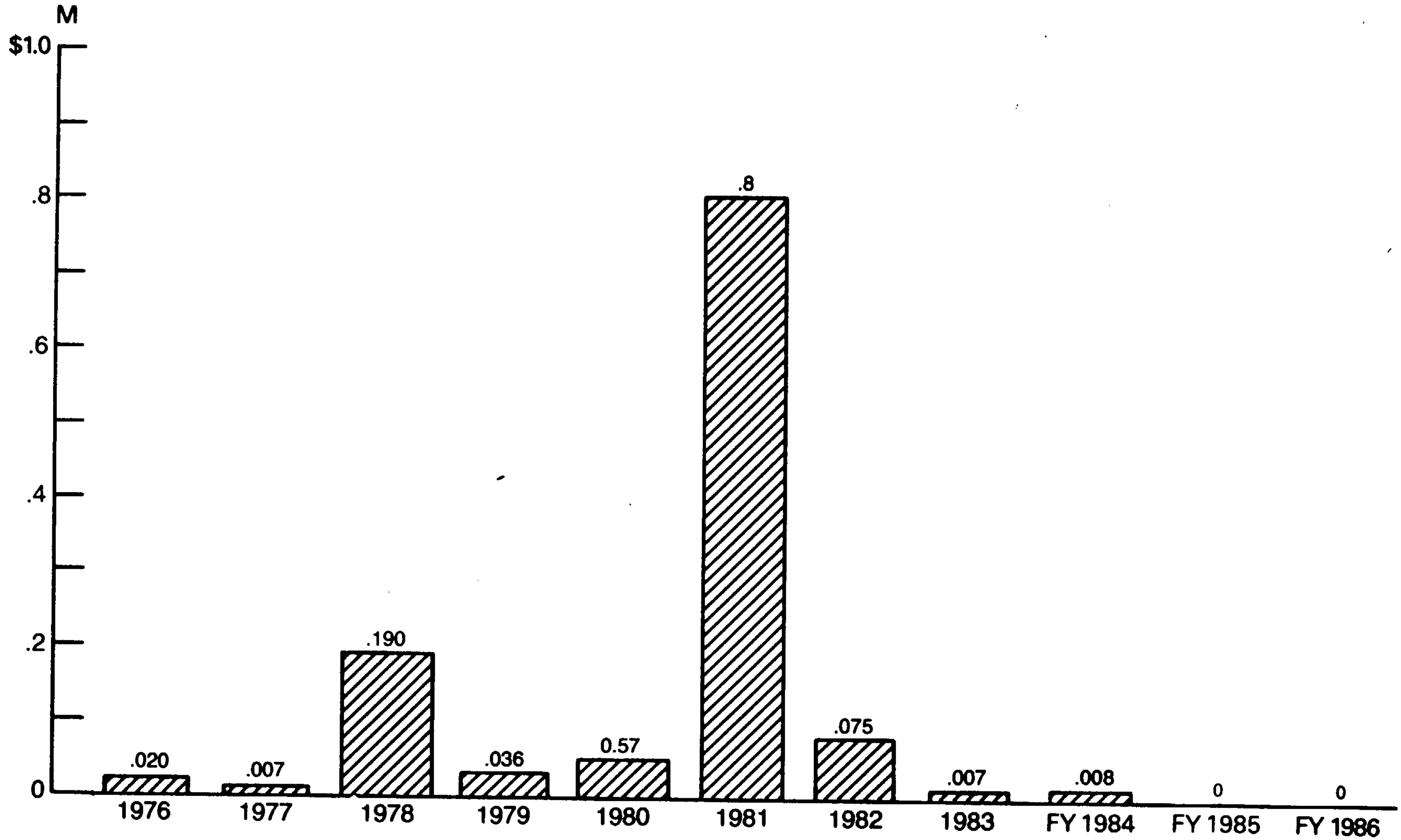
NASA FIRE HISTORY

1976-1986

DOES NOT INCLUDE TEST OPERATIONS OR MISSION FAILURES

NASA HQ QS86-397 (1)
Rev. 10-19-87

NASA FIRE LOSSES
(IN MILLIONS OF DOLLARS)
1976-1986



DOES NOT INCLUDE TEST OPERATIONS OR MISSION FAILURES

Figure 17
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NASA HQ QS86-396 (1)
Rev. 10-19-87

NASA MISHAP DEFINITIONS

TYPE A MISHAP: A mishap causing death, damage to equipment or property equal to or exceeding $500,000, destruction of an aircraft, or destruction of space hardware. NASA Type A mishaps are investigated by a board appointed by the appropriate program or institutional Associate Administrator.

TYPE B MISHAP: A mishap resulting in permanent disability to one or more persons, hospitalization of five or more persons, or damage to equipment or property costing from $250,000 to less than $500,000. NASA Type B mishaps are investigated by a board appointed by the director of the field installation.

TYPE C MISHAP: A mishap resulting in damage to equipment or property costing from $25,000 to less than $250,000, or causing occupational injury or illness which results in a lost workday (or workdays) or restricted duty. NASA Type C mishaps are analyzed locally by committees or individuals unless circumstances dictate a more formal investigation.

MISSION FAILURE: Any event of such a serious nature that it prevents accomplishment of the majority of the primary mission objectives. Mission failures are usually investigated by a formal board.

TEST FAILURE: An unexpected event which jeopardizes a test, prevents accomplishment of major test objectives, causes premature test termination, or destroys test hardware, test stands, or monitoring equipment. Test failures generally result in monetary losses of $25,000 or more, have significant impact on a particular program, or have political or public visibility. A program may call for the use of low cost models and other test items which are specifically designed to meet certain test conditions where damage is likely to occur. When these are damaged or destroyed, circumstances will determine if a test has in fact occurred or if the damage was a likely result of the test. Test failures are investigated or analyzed as determined by program personnel. (When a part or assembly fails without causing a significant monetary loss or program delay, a test failure, according to this definition, has not occurred.)

INCIDENT: An unplanned occurrence which results in injuries to personnel of less severity than those in a Type C mishap or which results in property loss or damage in excess of $500 but less that $25,000. A close call that could generate wide-spread interest may be included in this category.

CLOSE CALL: An unplanned occurrence in which there is no injury, property damage, or interruption of work, but which has the potential for any of these.

COSTS: Direct costs of repair, retest, delays, replacement, or recovery of NASA property including manhours, material, and contract costs but excluding indirect costs of cleanup, investigation, injury, and normal operational delay.

NASA MISHAP: Any unplanned event or anomaly that may be classified as a Type A, B, or C mishap, incident, or mission or test failure that involves NASA personnel, equipment, or facilities.

NASA CONTRACTOR MISHAP: Any unplanned event or anomaly that may be classified as a Type A, B, or C mishap, incident, or mission or test failure that involves NASA contractor personnel or equipment in support of operations at NASA. These are normally investigated by the contractor and reviewed by NASA, or depending upon the circumstances, investigated separately by NASA when directed by a NASA official with board appointment authority.

The significant mishaps shown in Tables 4 and 5 are those reported by the NASA field installations as having significance beyond the minor dollar losses or injury incident categories. These mishaps provide "lessons learned" for all NASA accident prevention programs.

Figure 18 presents an 11-year overview of NASA Type A, Type B, and Type C mishaps. The Type B and C mishaps reported here are those which resulted in property damage of an amount greater than $25,000. Type B and C personal injuries are reflected in Tables 1 and 2. The dollar limits for each category have escalated over the years due to inflation. NASA experienced a decrease in the number of serious accidents reported in FY 1986.

Figure 19 presents an 11-year history of NASA's total losses from chargeback billing costs, lost wages and material losses due to mishaps.

Table 6 compares the number of major mishaps experienced by the individual field installations, the lost-time rate of civil service and contractor employees, and the cost of material losses for the fiscal year against the installations' goals and the previous year's totals. In addition, the status of the pressure vessel recertification effort, begun in 1981, is also reported on this Table. NASA's goal is to complete initial inspection and analysis of all pressure vessels by the end of FY 1987.

TABLE 4. FATALITIES

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
NASA EMPLOYEES	0	2	0	1	0	4	1	0	0	0	3*
CONTRACTOR EMPLOYEES	1	3	1	0	0	5	1	0	1	1	6**
OTHERS	0	1	0	0	0	0	0	0	0	0	3*
TOTALS	1	6	1	1	0	9	2	0	1	1	12

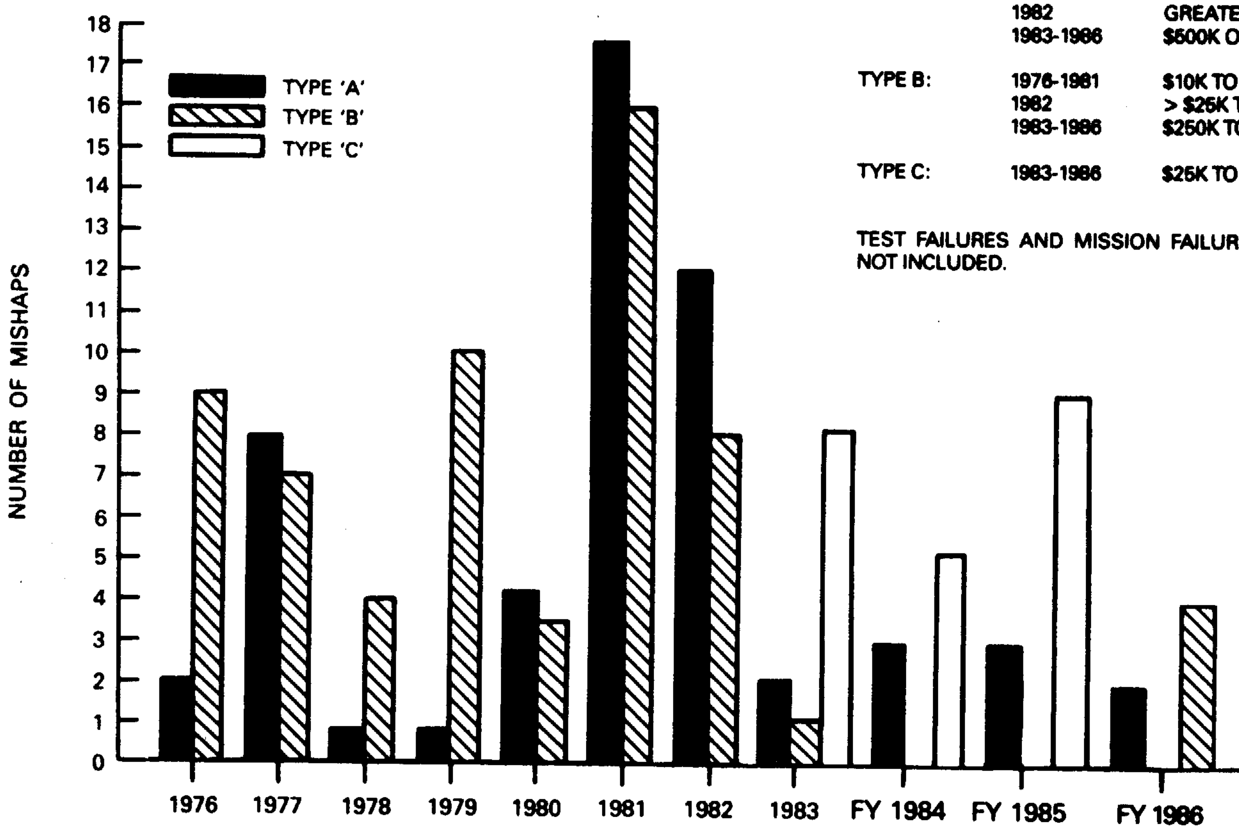
*Challenger fatalities
**1-Challenger; 1-ARC; 1-JSC; 3-KSC

TABLE 5. NASA TYPE A/B/C MISHAPS BY FIELD INSTALLATION

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ARC/DFRF	1/1	0/0	1/3	0/6	0/0	2/3	2/3	1/0/2	1/0/5	1/0/1	0/0/0
GSFC/WFF	0/2	1/4	0/0	0/1	1/1	0/3	1/0	1/0/1	0/0/0	0/0/1	1/0/0
HQ	0/0	0/1	0/0	0/0	0/0	0/0	0/0	0/0/0	0/0/0	0/0/0	0/0/0
JSC	0/0	2/1	0/0	0/2	1/0	2/0	0/1	0/0/0	0/0/0	0/0/0	1/0/0
KSC	0/0	2/1	0/0	0/0	0/1	5/3	1/2	0/0/1	0/0/0	0/0/6	1/0/2
LaRC	1/1	0/0	0/1	0/0	0/0	3/4	1/0	0/0/0	0/0/0	1/0/0	0/0/2
LeRC	0/1	0/0	0/0	1/1	0/0	0/2	0/0	0/0/2	0/0/0	1/0/1	0/0/0
MSFC	0/0	1/0	0/0	0/0	2/1	1/0	4/2	0/1/2	2/0/0	0/0/0	0/0/0
NSTL	0/1	1/0	0/0	0/0	0/0	1/1	1/0	0/0/0	0/0/0	0/0/0	0/0/0
TOTALS	2/6	7/7	1/5	1/10	4/3	14/16	10/8	2/1/8	3/0/5	3/0/9	3/0/4

1. Type "C" was first defined in 1983 and partially replaced the previously defined Type "B" mishap.
2. Types "B" and "C" individual injuries are not shown on this table. See Table 1.

NASA TYPE 'A', 'B', AND 'C' MISHAPS
1976-1986



TYPE A:	FATALITY	
	1976-1981	GREATER $100K
	1982	GREATER $250
	1983-1986	$500K OR GREATER
TYPE B:	1976-1981	$10K TO $100K
	1982	> $25K TO < $250K
	1983-1986	$250K TO < $500K
TYPE C:	1983-1986	$25K TO < $250K

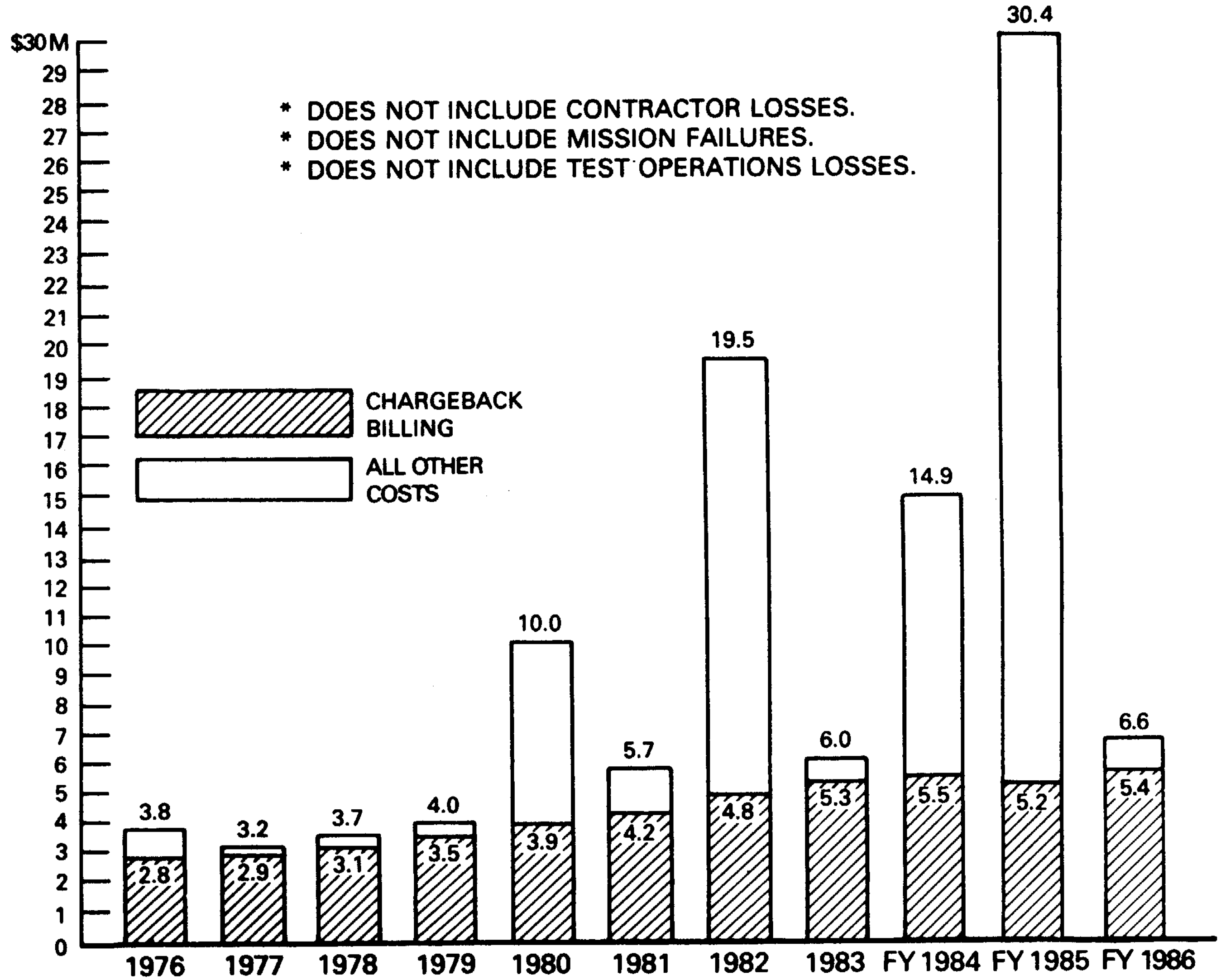
TEST FAILURES AND MISSION FAILURES ARE NOT INCLUDED.

Figure 18

NASA HQ QS86-403 (1)
Rev. 10-19-87

Figure 19

TOTAL COSTS TO NASA DUE TO MISHAPS*
(IN MILLIONS OF DOLLARS)
1976-1986



NASA HQ QS86-394 (1)
Rev. 10-19-87

TABLE 6. GOAL STATUS FOR FY 1986

	TYPE A & B MISHAPS			TYPE C MISHAPS			NASA EMPLOYEE L-T RATE			CONTRACTOR EMPLOYEE L-T RATE			MONETARY LOSSES ($K)			PRESSURE VESSEL RECERTIFICATION (% complete)	
	1985	GOAL 1986	STATUS	1985	GOAL 1986	STATUS	1985	GOAL 1986	STATUS	1985	GOAL 1986	STATUS	1985	GOAL 1986	STATUS	1985	1986
ARC	1	1	0	1	1	0	0.30	0.30	0.87	1.79	1.50	1.75	18,962.3	500	1.3	31	31
GSFC	0	0	1*	1	0	0	0.23	0.40	0.27	0.72	0.45	0.62	199.5	90	11.7	WFF 30 NSBF 10	40 14
HQ	0	0	0	0	0	0	0.50	0.30	0.51	0.26	0.30	0.67	4.8	0	2.0	--	--
JSC	0	0	1**	0	1	0	0.23	0.30	0.43	0.90	0.90	0.90	7.7	0	6.7	100 WSTF 100 DWPD 30	-- -- 30
KSC	0	0	1	6	1	2	0.59	0.30	0.09	0.68	0.80	0.61	893.1	500	764.0	5	6
LaRC	1	0	0	0	0	2	0.22	0.30	0.19	1.81	1.80	1.89	1,723.0	250	335.2	42	53
LeRC	1	0	0	1	0	0	0.82	0.60	0.93	1.74	1.00	2.04	3,203.9	100	.6	68	84
MSFC	0	1	0	0	1	0	0.33	0.30	0.33	1.56	0.90	1.69	7.5	500	6.9	90	100
NSTL	0	0	0	0	0	0	0	0.30	0	1.35	1.00	1.02	24.5	90	0	100	--
NASA	3	2	3	9	4	4	0.38	0.30	0.43	1.01	1.00	0.96	25,026.3	2550	1,128.4		

1. Goal for Type A mishaps is always zero. Mishap goals are for Types B and C property/equipment damage.
2. Mission and test failures are not considered in determination of goals.
3. Cost of Mission Failures is not included in total monetary losses.

* Delta 178 Mission Failure
** STS 51-L Mission Failure

MAJOR MISHAPS in FY 1986

16-FOOT WIND TUNNEL MISHAP
LANGLEY RESEARCH CENTER

On October 7, 1985, the first of two mishaps to the Langley Research Center's 16-foot wind tunnel occurred. A Lockheed turboprop, mounted on a NASA supplied model was tested at 0.8 Mach (M) when operators noted prop spin peculiarities and began to shut the tunnel down. At 0.4M, the prop nacelle tore off from the model and contacted the tunnel blades. Major damage was sustained by 10 blades and minor damage to at least 20. The committee investigating the failure determined the cause to have been fatigue of the balance beams. Criteria for returning the model to operation were established. NASA incurred an $82,000 loss.

The same test was initiated on October 29 to a test condition of 0.8M and propeller speed of 310 revolutions per second (rps). As the tunnel was brought up to speed, the propeller windmilled to 260 rps. Overload alarms sounded at 90 and 150 rps when the speed passed through resonance conditions. The air was turned on to the propeller motor and the speed increased from 260 to approximately 310 rps. The model failed 10 to 12 seconds after the air was turned on to the propeller motor. The motor/balance/propeller separated from the nacelle and was carried down the tunnel by the air flow. The tunnel was subsequently shut down and properly secured. Damage to the model and fan was extensive and initially estimated at $100,000-$150,000.

After the second mishap LaRC convened a board of investigation which determined that the most probable cause for failure of the model components was high dynamic loading due to loss of one or more propeller blades. Total damage cost was just under $250,000. The board recommended that LaRC develop model integrity criteria and update LHB 1710.15 to require design consideration of blade loss and encapsulating parts, to account for dynamic loads and/or instabilities, and to identify dynamic characteristics by analysis and/or tests. Also, among other recommendations, the board suggested that at least one reviewer of the model integrity report be familiar with loads and instabilities of rotating systems.

SRM HANDLING RING MISHAP
KENNEDY SPACE CENTER

On November 8, 1985, at the Kennedy Space Center the forward center segment of a left hand Solid Rocket Motor (SRM) was damaged during removal of the forward handling ring in the Rotation Processing and Storage Facility (RPSF). At the time of the mishap, the segment lifting beam had just been attached to the forward handling ring. Technicians had removed 98 of the 129 shipping pins which secure the segmented portions of the handling ring to the SRM segment case but had not loosened the 132 bolts connecting the segmented handling ring to the solid handling ring as required.

The lead technician decided to lift the approximate weight of the segment handling ring to aid in the removal of the remaining 31 shipping pins. He asked the crane ground controller, who was on the platform with him, to lift 11,000 pounds, the approximate weight of the handling ring. The crane ground controller relayed this information to the crane operator who initiated a very slow "up" command while watching the load cell digital indicator. RPSF taped radio transcripts revealed that after approximately 85 seconds, a loud bang was heard, and the segment lifting beam jumped upward; the load cell digital indicator read zero at this time. An emergency shutdown of the crane system was made, the area was secured, and an investigation of the mishap was begun. Damage to the SRM segment included distortion of the outer clevis leg forward of the pin hole in the 310° location, distortion of the pin hole, and cracks in the protective finish. The segmented handling ring and the solid handling ring were also damaged. The actual dollar loss was assessed at $500,000.

The investigation board found that work was not being done in the sequence prescribed by the OMI. The board recommended that a Management Alert stressing the necessity for compliance with the OMI be issued. A second finding was that the OMI procedure was inadequate to normally accomplish the task without engineering involvement and disposition. The board recommended that the OMI be reviewed and revised by Morton Thiokol Operations and Lockheed Space Operations Company (LSOC) Engineering to provide more complete instructions for safe pin removal when bound by the weight of the transportation handling ring.

Employee depositions indicated some lack of discipline in assuring compliance with the OMI sequences as well as follow-up in problem reporting. The board recommended that documented pre-test briefings be conducted to inform all participants of the critical elements of the operations and of their required participation. The board further recommended that the Team Leader's responsibility for the discipline of the team and for its performance be stressed to these individuals. In addition, the board learned that the lift technician coordinator was not adequately trained. The board recommended that a certification position for "critical lift coordinator" be established.

An apparent failure of the load cell system of the No. 2 200-ton RPSF Crane contributed to the damage of the SRM segment. Although the load cell digital indicator read zero at the time of the mishap, analysis of fracture evidence revealed that lifting forces were in excess of 215,000 pounds. The board recommended that Thiokol Operations and LSOC Crane management sign a mutual agreement that the cranes are safe and effective for use in the RPSF with the load cell system disabled. An additional recommendation was that specific operational requirements be established for the load cell's use prior to returning the cranes to service.

In light of the fact that the reporting of crane anomalies by the crane operating personnel is inconsistent, the board recommended that the anomaly reporting method be enforced by LSOC crane management. Written instructions should be attached to the cover of each logbook, and crew briefings should be held by management to emphasize the need to report and record all anomalies, regardless of their duration or immediate impact upon the operation in progress.

CONTRACTOR FATALITY
KENNEDY SPACE CENTER

A 32-year-old man employed by a NASA subcontractor was electrocuted on November 19, 1985, while his company was installing a hydraulic elevator at the Centaur Payload Operations Control Center (CPOCC) Phase I construction site, Cape Canaveral Air Force Station, Florida. The victim exhibited no apparent vital signs at the scene of the accident. He was transferred to Cape Canaveral Hospital where he was pronounced dead. A contractor board and a joint Air Force/NASA Review Committee were formed to look into the causes of the fatality.

The investigative teams learned that the lead mechanic in charge of the installation was in the process of installing an electrical conduit to the side of the elevator car when he was electrocuted. The source of the power was the 120-volt circuit that supplied the power for the elevator car lights, fan, convenience outlet, and work light on the top of the car. At the time of the mishap, the circuit coming into the elevator as well as the wire running to the elevator controller from the disconnect switch were run on a temporary basis. At no point in this run was the temporary wiring grounded. The victim himself had wired and connected the circuit from the devices on the elevator car to the elevator controller. For some reason he did not connect the ground wire to the ground lug in the controller. The hot wire in the car top junction box for the elevator cab lights was found to be shorted. Without a proper ground, a fuse did not blow, and the elevator car itself acted as a hot wire. Working between the elevator hoistway door jamb and the hot elevator car, the victim was electrocuted when he grounded himself as he touched the car.

At the time of the mishap, only one person at the site had been trained and certified in CPR. The investigation board recommended that electricians be qualified to administer first aid including mouth-to-mouth resuscitation and

CPR in the case of electrical shock. In addition, all construction sites should be required to have an adequate number of construction managers and craftsmen on all shifts trained in administering first aid.

It was discovered that prior to the arrival of safety officials and investigators, the scene of the mishap had been altered. The board emphasized that all personnel must be made aware that the scene of any mishap must not be disturbed. The mishap site is to remain secured until released by the safety investigator, chairman of the mishap board, or the Safety Director.

Lessons learned reflected the need to establish means to ensure that responsible individuals follow and enforce safety procedures specified in their company's policies and contractual government safety documentation. Also, documented verification for all grounding connections must be completed for both temporary and permanent wiring phases. Individuals doing this type of work must be made aware of the fact that low voltage can kill and that all circuits should be treated as live.

CONTRACTOR FATALITY
KENNEDY SPACE CENTER

An EG&G security patrol officer was killed in a motor vehicle accident at the Kennedy Space Center on February 7, 1986. The officer was responding to a reported automobile accident on NASA Causeway when he lost control of his vehicle, crossed the median, and collided with a northbound vehicle. The security officer was pronounced dead at Jess Parrish Hospital. The driver of the other vehicle was hospiitalized with multiple injuries. The Florida Highway patrol investigated the accident, and a NASA/KSC review panel was established.

CONTRACTOR FATALITY
AMES RESEARCH CENTER

On February 25, 1986, a Lockheed employee at the Ames Research Center suffocated while wearing a U2 high altitude pilot's helmet in a laboratory in Building N240. The helmet had been connected to a nitrogen-fed test apparatus. The deceased, a relatively new employee at ARC, had had eight years of experience and was certified in this type of work. A NASA Accident Investigating Board was appointed by the Director of the Ames Research Center.

CONTRACTOR FATALITY
KENNEDY SPACE CENTER

On March 24, 1986, a crane technician fell to his death while his company was installing a crane in the new Cargo Hazardous Servicing Facility (CHSF) in the Industrial Area of the Kennedy Space Center. The technician had just adjusted a pulley in the building high bay roof truss area and was returning to the crane when he apparently slipped and fell off a roof truss to his death 94 feet below. The technician was not wearing a safety belt at the time.

A Contractor Mishap Investigation Board was formed with a NASA board to review the contractor's investigation. As a result of the investigation, it was recommended that construction contractors be required to hold and document regular supervisor/worker safety/workmanship meetings. Also, construction contractors' safety plans should incorporate discussions concerning company policy regarding the use of protective equipment such as safety belts and hard hats, as well as company policy regarding violations of safety practices and penalties to be assessed. In addition, safety plans should provide examples of safety practice enforcement procedures to be used and should include statements from all subcontractors that they understand and will comply with the safety policies of the prime contractor. Finally, periodic, unscheduled surveillance of all construction sites should be performed by a representative of the government to ensure construction contractor compliance with good safety practices including enforcement and administration of violations.

CONTRACTOR FATALITY
JOHNSON SPACE CENTER

On August 26, 1986, a subcontractor at the Johnson Space Center lapsed into a coma after collapsing or falling into a utility tunnel in Building 17 during the installation of cable for a new telephone system. The employee was hospitalized in a comatose state and subsequently died on September 20, never having regained consciousness.

Extensive investigations of physical, environmental and physiological conditions associated with the mishap were conducted to determine the cause. Neither of the two most probable causes -- a pre-existing medical condition or exposure to electrical shock -- could be determined to be the precise cause of the accident. Based on an autopsy the Harris County, Texas, Medical Examiner stated that the cause of death was anoxic encephalopathy secondary to ventricular fibrillation.

MISSION FAILURES

LOSS OF CHALLENGER -- STS MISSION 51-L

On January 28, 1986, at 11:38 a.m. the Space Shuttle Challenger lifted off launch pad 39B at the Kennedy Space Center. Seventy-three seconds into a seemingly flawless ascent, an explosive burn of oxygen and hydrogen propellants destroyed the external tank and caused the complete structural breakup of the Orbiter. The solid rocket boosters flew out of the fireball and were destroyed by Air Force range safety officers 110 seconds after launch. All seven crew members perished as the Challenger's nose section, containing the crew module, plummeted into the ocean.

The Challenger was commanded by Maj. Francis "Dick" Scobee USAF (ret.) and carried mission specialists Dr. Judith A. Resnik and Ronald E. McNair, all NASA employees. Piloted by Com. Michael J. Smith USN, Challenger also carried mission specialist LTC Ellison S. Onizuka USAF, payload specialist Gregory B. Jarvis, an engineer with the Hughes Aircraft Corporation, and the first civilian participant in space, Teacher in Space S. Christa McAuliffe.

Shortly after the accident, President Reagan formed a Commission comprised of persons who had not been connected with mission 51-L to investigate the tragic mishap. The Commission's mandate was two-fold: 1) to review the circumstances surrounding the accident in order to establish the probable cause or causes; 2) to develop recommendations for corrective or other action based upon the Commission's findings and determinations. Following the suggestion of the Commission, NASA established several teams comprised of individuals who had not been involved in the mission 51-L launch process to support the Commission and its panels. These teams cooperated fully with the Commission in every aspect of its work, resulting in a comprehensive and complete investigation. In keeping with the 120-day time-frame established by President Reagan, Chairman William P. Rogers presented the Commission's report to the president on June 6, 1986.

As a result of their extensive investigation, members of the Commission concluded that the cause of the Challenger accident had been the failure of the pressure seal in the aft field joint of the right solid rocket motor (SRM). Among the nine major recommendations made by the Commission was a call for the redesign of the SRM joint and seal. At the end of fiscal year 1986 three of the nine recommendations had been fully implemented while the six remaining continued to be worked.

FAILURE OF DELTA 178/GOES-G

The Delta 178 was launched at 6:18 p.m. on May 3, 1986 from the Cape Canaveral Air Force Station. The mission objective was to place the GOES-G spacecraft into geosynchronous transfer orbit. Overall launch vehicle performance was normal from liftoff to approximately 71 seconds into flight when the main engine and vernier engines shut down prematurely. At 76 seconds into flight, large aerodynamic loads resulting from flight at an excessive angle of attack caused the vehicle to break up. The investigation board concluded that the mission failed due to the intermittent presence of a short circuit within the Delta 178 first stage electrical system. The short reduced the voltage available to the engine control relays which are self-energized through their own contacts in flight. The relays opened under the low voltage condition and shut down the main engine. The most probable cause of the short was mechanical damage to wire insulation induced by flight vibration.

The board found that although the high temperature environment was taken into account when the change from PVC to telflon wire was made, inadequate consideration was given to the abrasion resistance or mechanical damping afforded the wire harnesses by the overwraps, ties, and clamps of the previous design. It recommended that before the next launch a redesign of the center section and engine section wire harness be done to rectify known deficiencies. The board also discovered significant unexplained abnormalities in connector 263 as well as manufacturing quality defects in connectors 263 and 20. The implementation of measures to verify the quality of all connectors on the vehicle was recommended.

In addition, the board found that the Delta booster electrical control system is basically a simplex design with virtually no fault tolerance. It recommended the conduct of a review of the booster electrical control system for determiniation of single point failure locations, the assessment of risk potential for recurrence, and the incorporation of design changes to provide redundancy as appropriate for the next launch.